4.7 FUELS TECHNOLOGIES

The Fuels Technologies sub-program supports R&D to provide vehicle users with fuel options that are cost-competitive, enable high fuel economy, deliver lower emissions, and contribute to petroleum displacement. This sub-program supports the mission of FCVT to develop more energy-efficient and environmentally friendly highway transportation vehicles that enable the United States to use less petroleum.

The activities of the FCVT Fuels Technologies sub-program support the R&D goals of the FreedomCAR and Fuels Partnership and 21st CTP. Some activities are undertaken in coordination with the Biomass Program, HFCIT, and the Office of Fossil Energy via the Fuels Crosscut Team to ensure maximum synergy and to avoid duplication of effort. Fuels Technologies sub-program activities are also coordinated with appropriate DOE/industry technical teams; the light-duty automotive, heavy-duty engine, and energy industries; and federal, state, and local government agencies. Outputs from the Fuels Technologies sub-program are shared with the Advanced Combustion Engine R&D, Vehicle Systems, and Materials Technologies sub-programs in FCVT, and with others outside FCVT, as appropriate.

The FCVT Fuels Technologies sub-program has three component activities—Advanced Petroleum-Based Fuels (APBF) R&D, Non-Petroleum-Based Fuels (NPBF) R&D, and New Technology Impacts Research, as shown in Figure 21.

Discussion of the APBF and NPBF activities is combined in Section 4.7.1 because of similarities and synergies; the New Technology Impacts activity is discussed in Section 4.7.2.

4.7.1 Advanced Petroleum-Based Fuels and Non-Petroleum-Based Fuels R&D Activities

The APBF and NPBF activities are undertaken (1) to enable current and emerging advanced combustion engines and emission control systems to be as efficient as possible while meeting future emission standards, and (2) to reduce reliance on petroleum-based fuels. To differentiate these two activities, an APBF is envisioned as consisting of highly-refined petroleum derived from crude oil, possibly blended with performance-enhancing non-petroleum components derived from renewable resources such as biomass or from non-petroleum fossil resources such as natural gas or coal. In contrast, an NPBF is envisioned as consisting of a fuel or fuel-blending component derived primarily from non-crude-oil sources such as agricultural products, biomass, natural gas, or coal.

A major focus of both the APBF and NPBF activities is to determine the impacts of fuel properties on the efficiency, performance, and emissions of advanced ICEs. In the near term, these are expected, for the most part, to be direct-injection diesel engines. For the long term, the Fuels Technologies sub-program is focused on fuels optimized for advanced combustion regimes, a general term intended to include a variety of in-cylinder strategies that have the potential to provide diesel-like (or greater) efficiency with extremely low engine-out emissions. Homogeneous charge compression ignition (HCCI) and low-temperature combustion (LTC) are examples of such combustion regimes. Research will be conducted to identify fuel-related factors that can potentially foster (or hinder) the expansion of HCCI and LTC operating conditions to simultaneously achieve high engine efficiency and

Fuels Technologies
to support FreedomCAR and Fuel Partnership and 21st Century Truck Partnership

Activities

Advanced Petroleum-Based and Non-Petroleum-Based Fuels

- Fuels for high-efficiency 2007–2010 emission-compliant engines
- Fuels for advanced combustion regime engines
- Hydrogen transition fuels
- Petroleum displacement fuels/fuel blending components

New Technology Impacts

- Ecosystem impacts of new technologies

Fuels Technologies
Light-Duty Vehicles
Medium Trucks
Heavy Trucks

Collaboration

- H₂/Fuel Cells
- Biomass Energy
- Fossil Energy
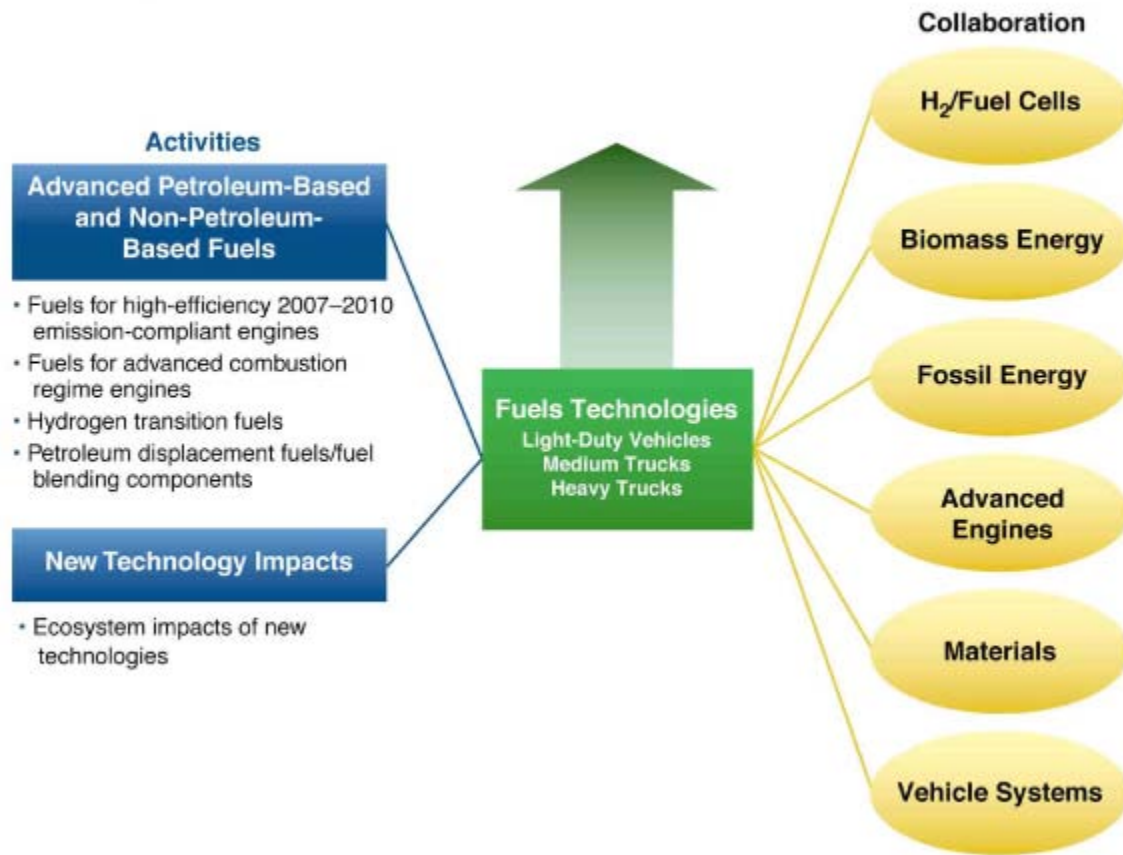- Advanced Engines
- Materials
- Vehicle Systems

Figure 21. Activities, collaborations, and outputs of the Fuel Technologies activity.

extremely low emissions. Consistent with the Federal R&D role, work will focus on longer-term, pre-competitive fuels technology areas with potential for commercial viability.

While some anecdotal evidence indicates that there are variations in performance and emissions in near-term engines (e.g., prototype Model Year 2007) related to fuel-property variations, it is almost certain that future, advanced combustion engine technologies will show a greater sensitivity to such variations. Therefore, co-development of fuels and engines is likely to be a necessary step in the post-2010 timeframe. This strategic approach of co-development necessitates a much-improved state of fundamental knowledge about fuel composition and properties and their impact on engine combustion phenomena. If fuel specifications need tighter definition for engine operation in advanced combustion regimes, close coordination between the Advanced Combustion Engine and Fuels Technologies sub-programs will be essential.

In addition to the goal of enabling advanced-combustion-regime engine technology shared with APBF activity, the NPBF activity has the goal of identifying practical, economical fuels and fuel-blending components with the potential to directly displace significant amounts of petroleum. These fuels and fuel

components are anticipated to be derived from non-fossil sources such as biomass, vegetable oils, and waste animal fats, as well as from fossil sources other than light, sweet crude oil (e.g., natural gas, heavy crude, tar (oil) sands, oil shale, and coal). The production of diesel fuel from these sources is technically feasible, yet none is in significant use in the United States because of their quality and/or cost. The NPBF activity focuses on the properties and quality of the finished fuels derived from these sources, not primarily on their production. Fuel production and processing issues are considered in coordination with the appropriate DOE entities through the Fuels Crosscut Team.

Goals

The general goal of the APBF and NPBF activities is to identify fuel formulations with increasingly significant use of non-petroleum fuel components that will enable emerging advanced ICEs to be more energy-efficient while meeting future emissions standards. Specific goals for these activities of the Fuels Technologies sub-program are as follows:

- By 2007, identify fuel formulations optimized for use in 2007–2010 technology *diesel* engines that incorporate use of non-petroleum-based blending components with the potential to achieve at least a 5% replacement of petroleum fuels.
- By 2010, identify fuel formulations optimized for use in *advanced combustion engines* (2010–2020) providing high efficiency and very low emissions, and validate that at least 5% replacement of petroleum fuels could be achieved in the following decade.

Programmatic Status

APBFs are critical to enabling diesel engines—currently the highest-efficiency engines available—to meet future emission standards. Future diesel-powered vehicles will be dependent on exhaust emission control devices to control NO_x and particulate emissions. The most desirable NO_x emission control devices are deactivated by sulfur in currently available fuels. An important objective of the APBF activity has been the determination of the diesel fuel sulfur level that can be tolerated by effective and durable NO_x emission control devices.

Although the EPA initially had not intended to issue a ruling on the sulfur content of diesel fuel, testing and analysis conducted by the APBF activity in collaboration with EPA, the engine manufacturers, emission control device manufacturers, and fuel producers conclusively demonstrated that fuel sulfur content had immediate adverse effects on the effectiveness of fresh emission control devices. This effort resulted in the EPA's issuing a final rule on January 18, 2001, that established a single comprehensive national control program to regulate heavy-duty vehicle emissions and diesel fuel as a single system. The diesel sulfur rule limits the amount of sulfur in on-highway diesel fuel to 15 ppm, beginning in 2006, in preparation for the start of implementation of the EPA 2007-2010 heavy-duty diesel engine emissions standards. These emission standards are the first for heavy-duty diesel engines that are expected to require exhaust emission-control devices.

The current base of knowledge suggests that NO_x-adsorbers—the leading candidate for exhaust aftertreatment device—may not be sufficiently durable and/or energy-efficient when exposed to fuel containing 15 ppm sulfur allowed under the 2006 standard. One promising approach to resolving this problem is to remove the major sulfur-containing compounds from fuel prior to combustion (i.e., at the fueling station or on board vehicles). The Fuels Technologies sub-program is funding work in this area in order to expand technological, non-regulatory approaches to solving any remaining sulfur and fuel-contaminant problems. Blends of NPBFs with APBFs can also be effective at reducing sulfur content and, in some cases, improving performance. In work previously funded by the Fuels Technologies sub-program, NPBFs, such as Fischer-Tropsch distillate, have also shown potential for synergistic emission reductions when paired with existing emissions control devices.

On July 30, 2001, EPA announced that it would request an independent review of the 2007 heavy-duty diesel engine emissions standards and the diesel fuel sulfur content standard to provide "advice to the EPA on technology issues associated with the introduction of technology to reduce engine exhaust emissions and technology to lower the sulfur level of highway diesel fuel in accordance with the dates incorporated in the highway diesel program promulgated in 2001." The Clean Diesel Independent Review Panel was thus created to carry out this review. The specific objectives of the panel's charter were to assess

- the progress of manufacturers of diesel engines and emission control systems in developing technology to reduce engine exhaust pollutants
- the progress of the fuels industry in developing and demonstrating technologies to cost-effectively lower the sulfur level of highway diesel fuel

The panel was composed of leading experts from the public health community, petroleum refiners, fuel distributors and marketers, engine manufacturers, emission control systems manufacturers, and state governments. In its final report, the panel found that NO_x adsorbers and catalyzed particulate filter systems are the two leading emission control technologies for diesel engines. It also identified improving the durability of the NO_x adsorber, especially as it relates to desulfation (removing accumulated sulfur), as the most significant fundamental challenge that is being addressed currently.

These findings directly support the research priorities of the Fuels Technologies sub-program. Although EPA has set a sulfur limit of 15 ppm, it is still unclear whether this is an adequately low sulfur level for advanced diesel engines with advanced emission control systems. The durability of these systems at this level of fuel sulfur has not been established. Also, with the pending introduction of emission control devices, the optimum fuel formulation for advanced diesel engines is undefined.

World crude oil is becoming heavier (lower API gravity) and more sour (including greater amounts of sulfur) over time. This trend is well established and is not expected to change. Moreover, a large proportion of domestic crude is heavy (e.g., California crude from the San Joaquin Valley), and many potential future sources of energy are heavier still (e.g., bituminous coal, oil sands). In addition to presenting different refining issues compared with light crude, the fuels produced from such feedstocks may differ from those for which our domestic refining industry is optimized.

At present, little detailed information on the chemistry of fuels is available. While such investigations of fuel chemistry are inherently complex, DOE's national laboratories have the expertise and facilities to begin an investigation into what physical and chemical properties are of most significance to advanced-combustion-regime engines. Such investigations are typically beyond the scope or business interest of the energy industry. Even if such information is sought by the energy industry, in most cases the specialized capabilities equivalent to those available at the national laboratories would not be available internally, and the resultant information would generally not be publicly available. The APBF and NPBF activities, therefore, have an important role to play in the pre-competitive arena by addressing these issues in partnership with the energy, engine and automotive industries.

Use of Venezuelan and domestic heavy crude in U.S. refineries is well-established. Refining of synthetic crude derived from oil sands is growing in use in Canada, and expansion into U.S. refinery feedstock is beginning. Fischer-Tropsch diesel fuels, synthesized from natural gas or coal, have been studied in numerous engine tests to determine their impact on emissions and have been used as a blending material in California diesel fuels since 1993. Use of similar fuels derived from biomass—biomass-to-liquid fuels—appears to be increasing in Europe. Tracking and exploiting some of these developments for the United States is a significant potential source of displacement of foreign petroleum and is, therefore, an important element of the NPBF activity.

Desirable attributes for NPBFs include compatibility with all aspects of the existing fueling infrastructure, and thus the capability to be used as replacements for current fuels, and a general lack of undesirable components, such as sulfur and aromatics. NPBFs with these characteristics are intended to enable the implementation of advanced-combustion-regime technologies. In addition, NPBFs will enable more-effective, more-durable, yet less-costly emission control systems requiring less energy for operation and therefore reducing the negative impact of those devices on vehicle efficiency.

Targets

In collaboration with the Advanced Combustion Engine sub-program (Sect. 4.5), fuels, engines, and emissions control devices are being addressed in the context of complete, integrated engine power systems. Table 41 lists the fuels-specific technical targets for APBFs and NPBFs that support crosscut targets with advanced combustion engine R&D (shown in italics), as well as direct petroleum fuel replacement targets.

Barriers

The primary goal of the APBF and NPBF activities is to identify fuel formulations with increasingly significant non-petroleum components that could replace petroleum fuels and that will enable emerging, advanced ICEs to be more energy-efficient while meeting future emissions standards. In order to fully exploit high-efficiency, clean advanced-combustion-regime engines, co-development of the engines and fuels is a necessity. The technical barriers to achieving this are as follows.

Table 41. Technical targets: Advanced Petroleum-Based and Non-Petroleum Based Fuels

Characteristic	Unit	2007 targets	2010 targets
Crosscut Targets with Advanced Combustion Engine R&D			
Engine efficiency	*%*	*>50 (heavy-duty engine)*	*30–45 (light-duty engine)*
NOx emissions	*g/bhp-h*	*<0.20 (50% phase-in)*	*<0.20*
PM emissions	*g/bhp-hr*	*<0.01*	*<0.01*
Durability	*Miles (equivalent)*	*120,000 light duty)* *435,000 (heavy duty)*	*120,000 (light duty)* *435,000 (heavy duty)*
APBF and NPBF targets			
Fuel sulfur level (available fuel)	ppm	15	15
Fuel sulfur level (w/on board or fuel-station based removal)	ppm	<5	<3
Emission control penalty reduction	%	50	>50
Fuel price differential	% of retail diesel	<5	<5
Potential for replacement of petroleum	%	At least 5	>5
Compatibility with infrastructure	NA	Validated	Validated

Health effects
    Unregulated toxics and
    ultra-fine PM
    Health and safety of fuel
	(by analysis)	No significant increase In composite risk compared with conventional fuels	No significant increase in composite risk compared with conventional fuels

Life-cycle greenhouse and criteria emissions	(by analysis)	No increase	No increase

A. **Inadequate data and predictive tools for fuel property effects on combustion and engine optimization.** Existing data and models for engine efficiency, emissions, and performance based on fuel properties and fuel-enabled engine designs or operating strategies are inadequate. They are limited in scope, have unexplained differences among various engine types, and do not adequately account for the effects that the physical properties and molecular structures of fuels have on the dynamic operation of the fuel injection system and the ability to operate in low-emission, LTC regimes. Also, the effect of the variability of refinery stream (blendstock) composition on the efficiency, performance, and emissions of engines appears to be significant but is poorly understood. The impacts on combustion and emissions are unknown for fuel strategies that enhance hydrogen infrastructure and foster the transition to a hydrogen economy.

B. **Inadequate data and predictive tools for fuel effects on emissions and emission control system impacts.** The database on the extent to which petroleum fuel and non-petroleum fuel components contribute to toxic emissions is inadequate and must be improved in order to optimize engine and aftertreatment systems from a fuel economy standpoint. The relationship between fuel properties and the formation of ultra-fine particles (i.e., particles of <0.1 nm in diameter) is not well established. Also inadequate are data on the effects of fuel properties (other than sulfur) on exhaust emission control

systems, and widely-accepted test procedures to measure these effects do not exist. Furthermore, suitable test equipment and universally-recognized test procedures with which to generate this knowledge base are not available.

C. **Long-term impact of fuel and lubricants on emission control systems.** The knowledge base is inadequate on the effect of fuel properties on the deterioration rates and durability of emission control system devices and components. The effects of lubricating oil on engine emissions and emission control devices are not clearly understood. Improved understanding is needed in developing approaches that mitigate any deleterious effects caused by fuel and lube oil components. Furthermore, new fuel formulations could require corresponding new lube oil formulations.

D. **Infrastructure.** The lack of a distribution and fueling infrastructure is a major barrier for any non-petroleum-based liquid fuel component that is not compatible with all current systems. This barrier must be addressed for non-fungible fuels to have a significant impact on reducing the transportation sector's dependence on petroleum-based fuels.

E. **Cost.** There are insufficient public data on refinery economics and processing strategies to enable comparison of options for APBFs and NPBFs. Also inadequate are the databases on the health, safety, and regulatory issues associated with most non-petroleum fuel components that might be used to replace petroleum-based fuels, and the knowledge base on the technical and economic impacts of non-petroleum fuel components on the distribution, storage, and fueling infrastructure.

Approach

The expertise of the national laboratories is used for in-house research and development efforts, in "working group"–level interactions in government-industry consortia, and in technical management. In the near term, fuel issues associated with 2007–2010 engines and emissions control systems are of immediate concern. Current work (2004) is focused on identifying the maximum tolerable fuel sulfur level for engines and emission control devices to meet useful life requirements with a minimal fuel penalty. This work is scheduled for completion in 2004. Included in this near-term focus are tasks that support removing sulfur from the fuel at fueling stations or on board the vehicle prior to combustion in order to provide a near-zero sulfur level, if necessary. For the long term, the challenge is development of a fuel specification optimized for operation of advanced-combustion-regime engines up to full load and during transients. Other challenges include assessing the implications of the properties of newly developed fuels on engine performance and emissions, and identifying compatible lubricants for use with newly developed fuels.

The APBF and NPBF activities will test and evaluate a wide variety of fuels to develop a better understanding of the relationships between fuel properties, engine efficiency, and emissions. Exhaust emission control devices are expected to be necessary to meet future emissions standards for diesel-powered vehicles. Fuels-compatibility testing will include such devices as they become available (through close collaboration with the Advanced Combustion Engine R&D sub-program).

Key deliverables from the APBF and NPBF activities will be test data and test-data–based analyses of the sensitivity of the performance and emissions of engines and emission control devices to fuel and lubricant properties. As data accumulate in the database, it will become increasingly feasible to predict fuel formulations with favorable properties to reduce emissions of NO_x and PM. In addition, some emission control strategies rely on reductants derived from the fuel to operate effectively, a fact that will be taken into account as required reductant properties are identified by the Advanced Combustion Engine R&D sub-program.

Guidance on the fuels to be tested and other tasks will be provided by representatives from the automotive, energy, and engine companies; industry associations; and national laboratories. Government/industry technical and supporting groups will make specific recommendations for task elements, data analyses, and overall direction.
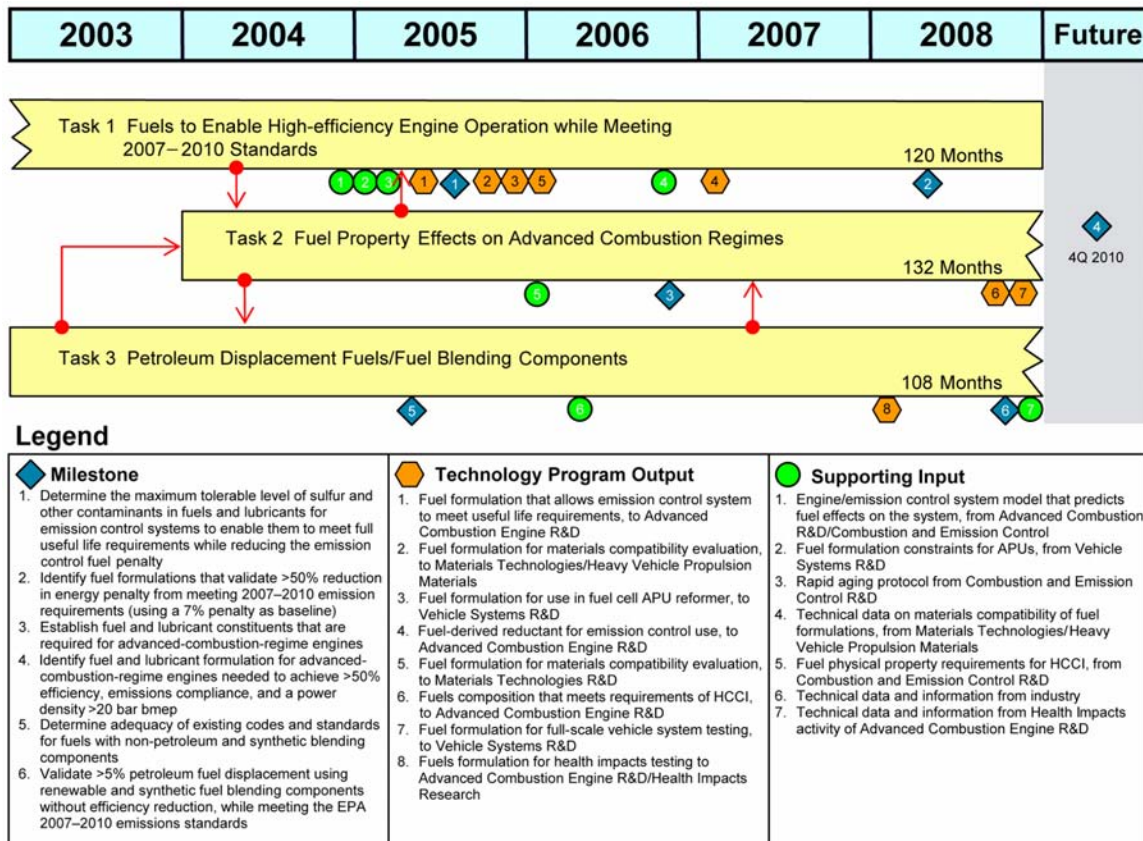
Task Descriptions

The technical task descriptions are provided in Table 42.

Milestones

The milestones for the APBF and NPBF activities are listed in the network chart.

Table 42. Tasks for APBF and NPBF		
Task	**Title**	**Duration/ barriers**
1	Fuels and Lubricants to Enable High-Efficiency Engine Operation while Meeting 2007–2010 Standards • Evaluate long-term degradation and loss of effectiveness of light- and heavy-duty engines equipped with 2007–2010 technology emission control devices and using 15-ppm-sulfur diesel fuel • Improve fundamental understanding of the effect of fuel and lubricant composition on aftertreatment systems by applying experimental and modeling approaches • Identify fuel properties other than sulfur that are critical to improving the efficiency, performance, and emissions of light-duty diesel engines and aftertreatment systems • Develop measurement techniques and characterize unregulated emissions from 2007–2010 engines and aftertreatment systems • Study fuels-based in-cylinder strategies to achieve high-efficiency, low-emissions operation at high power density and to improve understanding of hydrocarbon molecular structure effects on the sooting tendency of diesel fuel constituents	120 months Barriers A, B, C, D, E
2	Fuel Properties Effects on Advanced Combustion Regimes • Develop fundamental understanding of fuel effects on in-cylinder combustion and emissions formation processes in advanced combustion regimes through experimental and modeling approaches • Develop predictive tools that relate molecular structure to ignition behavior and heat release for fuels used in advanced combustion engines • Evaluate new fuels and fuel blends for efficiency, emissions, and operating stability with advanced combustion regimes • Evaluate the potential of reforming small amounts of fuel to generate additives that can be used to achieve fast control in low-temperature combustion modes • Evaluate the performance of traditional lubricant formulations in engines using advanced combustion regimes and identify any performance deficiencies	132 months Barriers A, B, C, E
3	Petroleum Displacement Fuels/Fuel Blending Components • Study combustion and emissions-formation processes of NPBFs and blending components using experimental and modeling approaches • Identify renewable and synthetic fuel blending components that provide enhanced efficiency, performance, and emissions characteristics • Quantify the potential for improving engine and/or vehicle fuel economy through the use of renewable biolubricants • Enhance the use of petroleum displacement fuels and NPBF infrastructure development through technical forums and by providing specialized technical support to early adaptors of advanced NPBF vehicle technologies • Review and revise, as required, appropriate codes and standards to increase the availability of petroleum displacement fuels	108 months Barrier A, B, C, D

2003	2004	2005	2006	2007	2008	Future

Task 1 Fuels to Enable High-efficiency Engine Operation while Meeting 2007–2010 Standards

120 Months

Task 2 Fuel Property Effects on Advanced Combustion Regimes

132 Months

4 4Q 2010

Task 3 Petroleum Displacement Fuels/Fuel Blending Components

108 Months

Legend

◆ Milestone

1. Determine the maximum tolerable level of sulfur and other contaminants in fuels and lubricants for emission control systems to enable them to meet full useful life requirements while reducing the emission control fuel penalty
2. Identify fuel formulations that validate >50% reduction in energy penalty from meeting 2007–2010 emission requirements (using a 7% penalty as baseline)
3. Establish fuel and lubricant constituents that are required for advanced-combustion-regime engines
4. Identify fuel and lubricant formulation for advanced-combustion-regime engines needed to achieve >50% efficiency, emissions compliance, and a power density >20 bar bmep
5. Determine adequacy of existing codes and standards for fuels with non-petroleum and synthetic blending components
6. Validate >5% petroleum fuel displacement using renewable and synthetic fuel blending components without efficiency reduction, while meeting the EPA 2007–2010 emissions standards

⬠ Technology Program Output

1. Fuel formulation that allows emission control system to meet useful life requirements, to Advanced Combustion Engine R&D
2. Fuel formulation for materials compatibility evaluation, to Materials Technologies/Heavy Vehicle Propulsion Materials
3. Fuel formulation for use in fuel cell APU reformer, to Vehicle Systems R&D
4. Fuel-derived reductant for emission control use, to Advanced Combustion Engine R&D
5. Fuel formulation for materials compatibility evaluation, to Materials Technologies R&D
6. Fuels composition that meets requirements of HCCI, to Advanced Combustion Engine R&D
7. Fuel formulation for full-scale vehicle system testing, to Vehicle Systems R&D
8. Fuels formulation for health impacts testing to Advanced Combustion Engine R&D/Health Impacts Research

● Supporting Input

1. Engine/emission control system model that predicts fuel effects on the system, from Advanced Combustion R&D/Combustion and Emission Control
2. Fuel formulation constraints for APUs, from Vehicle Systems R&D
3. Rapid aging protocol from Combustion and Emission Control R&D
4. Technical data on materials compatibility of fuel formulations, from Materials Technologies/Heavy Vehicle Propulsion Materials
5. Fuel physical property requirements for HCCI, from Combustion and Emission Control R&D
6. Technical data and information from industry
7. Technical data and information from Health Impacts activity of Advanced Combustion Engine R&D

4.7.2 New Technology Impacts

The New Technology Impacts Research activity supports the FCVT mission to ensure that advanced fuel formulations, which may eventually replace petroleum fuels in transportation, are environmentally friendly and do not produce adverse impacts on the ecosystem. This activity seeks to identify, analyze, quantify, and therefore avoid potentially deleterious ecosystem impacts of new technologies, specifically from fuels that are envisioned as replacing petroleum fuels.

Goals

The goal of the cross-cutting, comprehensive EERE-wide New Technology Impacts activity is to help ensure that EERE technologies brought to the marketplace by industry will be friendly to the Earth's ecosystem by providing a sound scientific basis for differentiating the contribution of new EERE technologies from current or existing competing technologies, and determining their potential relative impact on the environment. A sound scientific basis will be established through more accurate data and validated models.

Programmatic Status

New fuels and fuels technologies may have oftentimes unforeseen or unintended negative environmental impacts. Frequently in the past, it has been assumed that new fuels technologies will be eco-friendly. However, experience with

fuel additives such as tetraethyl lead and MTBE has shown the fallacy of such assumptions. Use of MTBE, an EPA-mandated gasoline additive to reduce carbon monoxide emissions, has resulted in serious groundwater contamination. And, recently, high amounts of toxic compounds such as formaldehyde and 1,3-butadiene have been measured in emissions from natural gas-powered vehicles.

To avoid unexpected, adverse environmental impacts from vehicle technologies being researched and developed by EERE and more specifically FCVT, the New Technology Impacts Research activity proactively evaluates the impacts on the ecosystem of changes in fuel, engine, and aftertreatment technologies when they are eventually implemented in transportation vehicles. FCVT research investigates impacts of whole exhaust, where air quality impacts are sometimes enhanced, and develops information that places environmental impacts of advanced fuels technologies in context relative to current fuels and technologies.

During 2003, this activity completed the study of the causes of elevated ozone on weekends in California's South Coast (Los Angeles) Air Basin. Findings of this study were reported in six technical papers that were published in the *Journal of the Air & Waste Management Association*. This study demonstrated that NO_x emission reductions in urban areas produced an unintended consequence: higher ambient urban ozone levels. An article that summarized the overall effort was published in the July 2003 issue of *EM* magazine, the most widely circulated magazine for air pollution professionals.

Targets

To quantify the impacts of changes in fuels, engines, and aftertreatments on pollutants emitted and their influence on the ecosystem, reliable and validated measurement methods and techniques will need to be developed that can be applied to accomplish the following:

- Measure the chemical and physical properties of vehicle emissions and distinguish emissions from different mobile source categories.
- Apportion emissions among various mobile sources, e.g., cars vs. trucks and one fuel type vs. another.
- Identify potential ecosystem impacts resulting from the introduction of new fuel technologies.
- Establish the scientific basis for quantifying impacts of emissions from new fuel technologies on the ecosystem.

Barriers

A. **Lack of accurate measurement tools and techniques.** As emission standards are tightened, precise, accurate measurement and characterization of engine emissions become more difficult. In addition, effective planning of regional and national air quality strategies requires knowledge of the air-quality effects of changes in the mix of pollutants as a result of the introduction of new engines and fuels.

B. **Lack of validated models.** Several recent studies have highlighted major differences between measured emissions from various sources and the emission inventories predicted by current models used to set policies to improve air quality (e.g., EPA's MOBILE6 vehicle emissions model). Such uncertainties are

leading to the establishment of policies detrimental to specific technologies and exacerbating air quality problems by prescribing incorrect approaches.

C. **Lack of adequate information regarding ecosystem, health, and safety impacts.** Engine manufacturers are testing additional fuels and fuel technologies to meet increasingly stringent emissions regulations. However, little information currently exists regarding many possible impacts from those new fuel and technology combinations.

Approach

To validate or remediate the shortcomings of currently used models, several studies are conducted concurrently to enable a more scientific and rational approach to identifying and quantifying specific contributions of mobile-source emissions from new fuels and EERE-developed technologies. The activity will be expanded to be inclusive of EERE-wide technologies. Planning sessions will be scheduled in 2004 to solicit input from EERE stakeholders.

Task Descriptions

A description of each technical task, along with the estimated duration and technical barriers associated with the task, is provided in Table 43.

Task	Title	Duration/ Barriers
1	Gasoline Vehicle PM Study in Kansas City • Collect on-road vehicle emissions data to serve as a basis for validating and updating the EPA MOBILE6.1 vehicle emissions model	48 months Barriers A, B
2	Air Toxics Source Apportionment Study • Conduct an ambient study to identify pollution source types responsible for elevated air toxics pollutant concentrations in the Los Angeles area	30 months Barriers A, B
3	*Three-City Weekend Ozone and PM Apportionment Study* • Perform a field study to investigate weekend ozone levels and their relationship to emission changes that occur on weekends relative to weekdays, and perform source apportionment of ambient particulate matter in three U.S. cities	24 months Barriers A, B
4	2007 Diesel Particulate Measurement Research Study • Begin E-66 study, designed to develop and validate PM sampling methods needed to meet EPA's 2007 new heavy-duty engine certification standards	18 months Barriers A, B
5	Weekend PM Nitrate Study • Complete a study of the relationship between large decreases in weekend NO_X emissions and their influence on particulate nitrate concentrations in Los Angeles	10 months Barriers A, B
6	R&D Planning • Conduct workshops to provide technical support to EERE and to solicit EERE stakeholder input • Plan studies to evaluate the accuracy of emission inventories for elemental and organic particulate carbon emissions for global climate change issues • Provide technical input and support for the Advanced Collaborative Emissions Study	60 months

Table 43. Tasks for New Technology Impacts

Milestones

The New Technology Impacts activity milestones are provided in the network chart.

2003	2004	2005	2006	2007	2008	Future

Task 1 Gasoline Vehicle PM Study in Kansas City — 48 Months

Task 2 Air Toxics Source Apportionment Study — 30 Months

Task 3 Three-City Weekend Ozone and PM Apportionment Study — 24 Months

Task 4 2007 Diesel PM Research Study — 18 Months

Task 5 Weekend PM Nitrate Study — 10 Months

Task 6 R&D Planning — 60 Months

Legend

◆ Milestone

1. Begin pilot study phase of Kansas City gasoline vehicle PM study
2. Begin air toxics source apportionment study in Los Angeles
3. Begin three-city weekend ozone and PM apportionment study
4. Begin 2007 diesel particulate measurement research study
5. Complete weekend PM nitrate study
6. Conduct workshop to solicit stakeholder input for a more expanded scope of studies to identify ecosystem impacts of new technologies being developed by FCVT
7. Initiate multi-year planning for New Technology Impacts R&D; provide technical guidance for Advanced Collaborative Emissions Study
8. Complete R&D Plan

⬡ Technology Program Output

1. Results disseminated to industry, technical community and the public through refereed journals
2. Technical data on ecosystem impacts of fuel formulations to the APBF/NPBF activities

● Supporting Input

1. Input on R&D opportunities from industry
2. Input on R&D opportunities from APBF/NPBF
3. Input on R&D opportunities from EERE programs
4. Fuels formulation for ecosystem impacts testing from APBF/NPBF activities